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PREDICTING ACADEMIC ACHIEVEMENTS OF ENGINEERING AND SCIENCE STUDENTS IN ISRAEL.

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A LONGITUDINAL STUDY (HIGH SCHOOL THROUGH COLLEGE) WAS CARRIED OUT AT THE TECHNION-ISRAEL INSTITUTE OF TECHNOLOGY TO INVESTIGATE ACADEMIC PREDICTORS AND PROBLEMS RELATED TO PREDICTION. FOR FOUR YEARS, THREE CLASSES OF 1,087 ENGINEERING STUDENTS WERE FOLLOWED. INTELLECTIVE PREDICTORS AND ACADEMIC CRITERIA ALONE WERE INVESTIGATED. HIGH SCHOOL AND MATRICULATION CERTIFICATE GRADES, TECHNION'S PREDICTORS (ENTRANCE EXAMINATION GRADES AND THE MATRICULATION CERTIFICATE COMBINED) WERE CONSIDERED. AVERAGE YEARLY GRADES IN TECHNION WERE THE ACADEMIC CRITERIA. TECHNION'S ENTRANCE EXAMINATION (MATH AND PHYSICS) WAS THE BEST SINGLE PREDICTOR FOR THE FIRST TWO YEARS. THE HIGH SCHOOL MATRICULATION CERTIFICATE WAS A BETTER PREDICTOR FOR LATER YEARS. GRADES IN HUMANITIES WERE BETTER PREDICTORS IN LATER YEARS FOR A HOMOGENEOUS POPULATION IN THE SCIENCES. GRADES IN PHYSICS AND CHEMISTRY WERE BETTER PREDICTORS THAN MATHEMATICS. MATRICULATION CERTIFICATE GRADES WERE NOT HIGHLY RELIABLE PREDICTORS. THE POPULATION IS HETEROGENEOUS ENOUGH TO REQUIRE SPECIAL SELECTION PROCEDURES FOR EACH DEPARTMENT. NOTIONS ABOUT PREDICTIVE VALUE AND SUBJECT WEIGHTING IN THE FRESHMEN YEAR SHOULD BE RE-EXAMINED. CONSIDERATION OF PREVIOUS ACHIEVEMENTS IN PROMOTION PROCEDURES MAY IMPROVE PREDICTION. THIS SPEECH WAS PRESENTED AT THE AMERICAN EDUCATIONAL RESEARCH ASSOCIATION CONVENTION, CHICAGO, ILLINOIS, FEBRUARY, 1968. (AUTHOR/PS)

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# PREDICTING ACADEMIC ACHIEVEMENTS OF ENGINEERING AND SCIENCE STUDENTS IN ISRAEL*

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## ABSTRACT

### Predicting Academic Achievements of Engineering and Science Students in Israel



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In comparison to the voluminous prediction studies in the United States, very little has been done in other countries. It would be of interest to compare results obtained abroad in different situations with those obtained in the United States. A longitudinal study (high school through college) was carried out at the Technion-Israel Institute of Technology, attempting to investigate, among other prediction issues, some problems raised by American reviewers which have received little attention. Three classes of 1087 students were followed up for four years. Intelective predictors and academic criteria alone were investigated. High school and Matriculation certificate grades, Technion's entrance examination, grades in specific subjects and the Technion's predictors (a combined grades of the Technion entrance examinations and the Matriculation certificate) were considered. Average yearly grades in the Technion were the academic criteria.

The Technion's entrance examination (Math and Physics) was the best single predictor in the first two years. The High School Matriculation Certificate was better in later years. Grades in Humanities were better predictors in later years for a relatively homogeneous population in the sciences. Grades in physics and chemistry were better predictors than mathematics. Matriculation Certificate grades did not prove to be highly reliable predictors as expected by the Ministry of Education. The population (a college of engineering) is heterogeneous enough to require special selection procedures for each department. Accepted notions about the predictive value and the weight that should be given to certain subjects in freshmen year should be re-examined. Consideration of previous years achievements in promotion procedures may improve prediction.

# PREDICTING ACADEMIC ACHIEVEMENTS OF ENGINEERING AND SCIENCE COLLEGE STUDENTS:*

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In the United States, high school grades generally have been found to be somewhat superior to test scores as predictors of college achievement for the freshman year but significantly inferior to a combination of high school grades and test scores. (Bloom and Peters, 1961; Fishman, 1962; Young, 1965) Most correlations reported fall in the range of .45-.55. Lavin (1965) states that with few exceptions, studies of academic performance are of a static rather than a longitudinal design. Problems such as the consistency of academic performance from Freshman through Senior years of college, or variables that may be solved with longitudinal designs. In comparison to voluminous studies which have been carried on in the United States, very little has been done in other countries. It would be of interest to compare some of the results obtained abroad in different situations with those obtained in the United States.

The following is a report of a longitudinal (high school through college) study carried out at the Technion - Israel Institute of Technology from 1961 to 1965. An attempt was made to investigate some of the problems raised by Lavin, which have received relatively little attention even in the United States. Before proceeding, it seems essential to provide the reader who is not familiar with the educational system in Israel with some background information about Israeli high schools, matriculation examinations and the Technion.

## The High Schools and the Matriculation Examination

Until recently, most Israeli high schools were mainly academic, college preparatory schools. The curriculum, methods of teaching, and evaluation were geared to the basic function of preparing students for the governmental matriculation examination, which entitles those who succeed to a Matriculation Certificate ("Teudat Bagrut"). This certificate is perceived by schools, parents, students and the public at large, not only as a proficiency certificate which entitles its holder to proceed with his studies in universities, but also as an important status symbol and, in many instances, an employment requirement.

Most Israeli high schools, supervised by the Ministry of Education and Culture, are accredited. Graduates of accredited schools have, among other things, one important advantage over graduates of other schools. In determining the final grades of their student's Matriculation Certificate equal weight is given to the Matriculation Examination grade and the high school final grade. Although students from non-accredited schools as well as adults are eligible for the examination, no consideration is given to their high school grades. If high school grades given by a particular school are very high in comparison to the examination grades, the school may be penalized and even lose its accreditation. However, if the difference is not more than one grade, the student will receive the higher grade. Each student is examined in six to eight subjects, according to his area of specialization.

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*Professor S. Sacks, at present Kansas State University has advised on the statistical methods and analysis of results. Professor H. Hanani, Dr. M. Yadin and Mr. S. Shimron contributed valuable remarks. Mr. Y. Rom assisted in the pilot study. Professor G. Glass, University of Illinois was helpful in the preparation of the English transcript. The author is indebted to them.

## The Technion - Israel Institute of Technology

The Technion is the only engineering school in Israel. Compared to engineering schools in the United States and Europe, it is considered to have rigorous standards. Admission to the Technion, as well as to other universities in Israel, requires a Matriculation Certificate. In addition, there are competitive entrance examinations and those of the Matriculation Certificate are averaged and those who score the highest are admitted. Since some departments cannot admit all candidates who have registered, the average score will also determine to which department the student will be admitted (he gives three priorities during registration). In other universities in Israel, three years are required to obtain B.Sc. degree (which is accredited in the United States and other countries). At the Technion four years are required for a B.Sc.

During the first two years, the students of all departments study almost the same curricula. Most of the time is devoted to basic sciences and general engineering courses. A very small portion of the curriculum is devoted to general studies. It is assumed that general education has been acquired in the academic high school. Further, in a follow-up study on students in institutes of higher learning in Israel, Technion students had the highest mean grade on the Matriculation Certificate.

It is a highly select group and the persistence rate is high. Eighty to 85% of those entering the Technion graduate and it is estimated that from those who have to leave, about half register in other universities or are graduated from engineering schools abroad. To be promoted from year to year in the Technion, a passing grade in each subject is not enough. The student has to achieve a required general average. Those who do not achieve this average must repeat certain examinations, or the whole year, or leave the Technion.

## The Problem

Since this was one of the first longitudinal studies of such problems conducted in Israel, an attempt was made to investigate many problems that have been raised in the literature. This report will refer to some of them. The purposes of this phase of the study were as follows: 1) To find out the most effective predictors of academic achievement in the Technion. 2) To compare the advantages of certain statistical methods in prediction studies over others. 3) To find out if high school grades in humanities and social studies would be good predictors. 4) To find out if there are significant differences in the above findings between the Technion's population as a whole, and students in the various departments. 5) To provide the Ministry of Education and Culture with information concerning the relation between the Matriculation and high school grades. This information is of great importance to the future development of secondary education in Israel.

## Procedures

### Population

The classes starting their studies at the Technion in the years 1958, 1959, and 1960 were investigated. The total population of the three classes combined was 1,087 students. A four-year follow-up of each class was made.

### Predictors and Criteria

Intellective perdictors and academic criteria alone were investigated in this study. This choice of variables was determined by the fact that candidates are not required to take any standardized tests of intellective characteristics or of non-intellective personality characteristics. Average high school grades of both accredited and non-accredited schools, average Matriculation Certificate grades, Matriculation and Entrance Examination

grades, grades in specific subjects and Technion predictors were considered. The criterion variables were the passing average yearly grades.

## The Statistical Method

The study was conducted in two phases. In the first phase, Pearson product-moment correlation coefficients were utilized in the statistical analysis. In the second phase, multiple correlations and multiple regression procedures were used.

## Results

### Technion Predictors (T.P.) (Table 1)

The Technion's present predictor (a combined score of the mean entrance examination grade and the mean Matriculation Certificate grade) was found to be the best predictor of academic achievement in the Technion. In the first phase of the analysis, when Pearson's correlation formula was used in the analysis and the simple average of grades was used as the predictor, the correlation for the four successive years were .55, .43, .28 and .25. In the second phase, the use of the multiple correlation and regression analysis improved the results very slightly. The correlations obtained were .57, .43, .30, and .26, for the four successive years.

The Technion predictor does not differentiate between students from accredited and non-accredited high schools. However, when such differentiation was made in this study, the correlations obtained for students from accredited high schools were higher than all students combined: .59, .56, .34, and .28 for the four successive years. The correlations for students from non-accredited high schools were much lower: .44, .31, .21, and .26.

The regression analysis indicates that giving more weight to the Matriculation Certificate of students from accredited high schools will result in higher correlations. On the other hand, for students of non-accredited high schools more weight should be given to the Technion's Entrance Examination.

Correlation between the Technion Predictor and achievements in the Freshman year, for the population as a whole, was .57, within departments there was a range from .37 in Chemistry to .78 in Aeronautical Engineering. The regression weights also differ in various departments. In some, more weight is given to the Entrance Examination and in the others to the Matriculation Certificate. As for the later years, correlations are lower. However, when compared to other studies, relatively high correlations were obtained for our population.

In a further step, a multiple correlation and regression analysis was made whereby five separate grades of the Matriculation Certificate were introduced as variables instead of the mean grade. This too raised slightly the correlation coefficients. This was found to be true for the Technion's population as a whole and for separate departments.

### Technion Entrance Examination (T.E.E.) Matriculation Certificate (M.C.) and Accredited High School Grades (A.H.S.) (Table 2)

The Technion Entrance Examination has a lower correlation than the Technion Predictor (.57). The mean grade of both examinations yielded higher correlations than the separate grades on each examination, and the physics grade was a better predictor than the mathematics grade.

Matriculation Certificate grades and high school grades yielded lower correlations than the Technion predictors. However, there was no great difference between their own prediction power.

Grades in Specific Subjects in the Matriculation Certificate, (Table 3)

In general, there is a low correlation between grades in the Matriculation Certificate and average yearly grades in the Technion. Correlation between Matriculation grades in physics, chemistry and average yearly grades are generally higher than those of mathematics. The grades in history and the highest correlation with achievement in the fourth year.

## Discussion and Conclusions

The Technion's predictor was found to be the most reliable. This result resembles those obtained in the United States for combined predictors, such as high schools and test grades. However, it should be remembered that in the Technion's case the equivalent to the American "test" variable is a combined grade in mathematics and physics. The Technion's predictor was the best only with students from accredited high schools. In the case of students from non-accredited high schools, correlation were lower even than the results for the Technion's entrance examination.

In the past, the Technion did not distinguish between the Matriculation Certificate of accredited and non-accredited high schools. However, in 1966 it was decided to make such a distinction and to give more weight to the Matriculation Certificate grades of students from accredited high schools.

The use of a multiple correlation and regression resulted in higher correlations. The regression analysis indicated that if some subjects in the Matriculation Certificate were given different weights than those given at the present, better correlations would be obtained. However, the specific weight given to the various subjects is a matter for further research.

The Technion's Entrance Examination was the best single predictor in the first two years. This is somewhat different than the results in the United States where high school grades have generally been found to be the best single predictor. However, correlations in the first two years were relatively low, not much higher than those of accredited high school grades. In the last two years, all correlations are lower and the difference is even smaller. In the third year, the rank order was reversed. The Matriculation Certificate grades of accredited high schools, which are already a combination of two variables, yielded somewhat higher correlations but not as high as those of the Entrance Examination.*

Technion students are mainly high school graduates who have specialized in the sciences. The results obtained indicated that for this population, high school grades in the humanities were somewhat better predictors of achievements in the Technion, especially in the last two years. One explanation of this result is that the population is already selective and relatively homogeneous in regard to ability and high school achievements in science and technical courses. Moreover, it becomes even more homogeneous after the attrition in the first two years of study at the Technion. It would seem therefore, that in the later years of engineering school, when the student is confronted with projects, problem solving processes and decision making, a good general education background may differentiate between the weak and the strong.

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*It may be interesting to note that in one stage during the study when Professor B. S. Bloom was visiting Israel, an attempt was made, under his direction, to scale some of the grades for one group of 141 students from accredited high schools. The improvement in the correlation was not very significant; however, this could be attributed to the highly homogenous nature of the group and its relatively small size.

These results have important implications for curriculum planners and students who specialize in the sciences. The amount of general education they receive in high school is smaller than those who specialize in the humanities. Many of them tend to minimize the importance of such studies for the future engineer or scientist. Unfortunately, at the Technion itself they receive only two weekly hours in general studies.

In the area of basic science courses, mathematics has always received much weight. It is generally assumed by many Technion people that the "queen" of sciences would be the best predictor. However, the findings did not support this assumption. Grades in physics and chemistry had better correlation with achievement.

Like many other engineering schools, the Technion tends to assume that the population candidates for registration is a very homogeneous group; therefore, the same selection instrument could be utilized for the whole group. But there are many differences between departments. Among these, differences in curriculum, in the extent of relationships between the science courses in the first two years and the engineering courses in the later years, as well as methods of teaching and evaluation. All these factors have implications for selection instruments and predictors.

Engineering schools try to emphasize the role of basic science courses in the curriculum of the first and second years. Some departments relate their teaching in the third and fourth year to this kind of basic preparation. On the other hand, there are those departments where there is no such relationship. These facts influence the degree of correlation between a certain predictor and academic achievements.

Finally, one other purpose of this study was to provide the Israeli Ministry of Education and Culture with information on the effectiveness of the Matriculation Certificate grades in predicting achievement in higher education. This information is of great importance since there is a growing feeling among educators in Israel that the present system of Matriculation Certificate Examinations should be modified. The status and prestige attached to it does not enable the development of a good comprehensive system of secondary education which will provide the right education to each student according to his abilities and needs. Moreover, if this Certificate does not prove to be highly reliable predictor of success in higher education, then there is less justification for continuing the present system.

Some of these comments were already stated by the writer in the Israeli literature (1965) and (1967). Chen and others (1966) report the results of another prediction study of Israeli high school graduates and their success in higher education. Their findings are similar to the foregoing and have reached the same conclusion regarding the need for the re-evaluation of the role of the Israeli Matriculation Certificate in secondary education.

## References


1. Bloom, S. S., and Peters, F. R., Academic Prediction Scales, The Free Press, Glencoe, 1961.
2. Fishman, J. A., "Some Social-Psychological Theory for Selecting and Guiding Course Students," in The American College, New York, John Wiley and Sons, 1962.
3. Lavin, D. E., The Prediction of Academic Performance, A Theoretical Analysis and Review of Research, New York, Russell Sage Foundation, 1965.
4. Young, G. D., "Students," in Higher Education-Review of Educational Research, Volume XXXV, No. 4, October 1965.
5. Perlberg, A., "Predicting Scholastic Achievements of Technion Students," Megamot, Child Welfare Research Quarterly, Volume XIV, No. 3, 1965, Jerusalem (In Hebrew).
6. Perlberg, A., "How to Predict Academic Achievements in the Technion" Megamot. Behavioral Science Quarterly, Volume XVIII, No. 1, 1967, Jerusalem, (In Hebrew).
7. Chen, M. and Doron, R. and Yaziv, G., "The Value of the Bagrut Matriculation Examination in Predicting Success in High Studies." Megamot - Child Welfare Research Quarterly, Volume XIV, No. 4, 1966, Jerusalem. (In Hebrew).

TABLE 1

SIMPLE AND MULTIPLE CORRELATIONS OF TECHNION PREDICTORS (T.P.) WITH AVERAGE YEARLY GRADES (A.Y.G.) FOR THE WHOLE POPULATION AND ACCORDING TO DEPARTMENTS

| Criteria / Predictor and Population | A.Y.G. Freshmen | | A.Y.G. Sophomore | | A.Y.G. Junior | | A.Y.G. Senior | |
|---|---|---|---|---|---|---|---|---|
| | N | R | N | R | N | R | N | R |
| T.P.[1](simple correlation) | 733 | (r).55 | 674 | (r).43 | 675 | (r).28 | 622 | (r).25 |
| T.P. | 733 | .57 | 674 | .43 | 675 | .30 | 622 | .26 |
| T.P.a[2] | 624 | .59 | 571 | .56 | 568 | .34 | 522 | .28 |
| T.P.b[3] | 109 | .44 | 103 | .31 | 107 | x | 100 | .28 |
| Industrial and Management Engineering | 126 | .56 | 112 | .46 | 115 | .36 | 103 | .31 |
| Civil Engineering | 41 | .50 | 34 | .39 | 38 | .38 | 35 | x |
| Architecture and Town Planning | 44 | .42 | 45 | x | 43 | .34 | 38 | .44 |
| Mechanical Engineering | 165 | .47 | 153 | .31 | 53 | .28 | 144 | .18 |
| Electrical Engineering | 123 | .44 | 118 | .49 | 118 | .34 | 112 | x |
| Mathematics and Physics | 52 | .66 | 49 | .70 | 47 | .32 | 45 | .36 |
| Chemistry | 24 | .37 | 24 | .62 | 23 | .56 | 22 | .51 |
| Chemical Engineering | 85 | .71 | 74 | .62 | 75 | .51 | 69 | .40 |
| Agricultural Education | 32 | .42 | 31 | .41 | 28 | .44 | 25 | .38 |
| Aeronautical Engineering | 46 | .78 | 39 | .73 | 40 | .58 | 34 | .68 |

[1]T.P. Technion Predictor. [2]T.P.a Accredited High Schools. [3]T.P.b Non-accredited High School.

All correlations are significant at .01 level. x refers to very low positive correlations, not significant statistically, which were omitted.

TABLE 2

CORRELATION OF TECHNION ENTRANCE EXAMINATIONS, (T.E.E.) MATRICULATION CERTIFICATE (M.C.) AND ACCREDITED HIGH SCHOOL GRADES (A.H.S.) WITH AVERAGE YEARLY GRADES

| Criteria / Predictor | A.Y.G. Freshmen | A.Y.G. Sophomore | A.Y.G. Junior | A.Y.G. Senior |
|---|---|---|---|---|
| T.E.E. Mathematics | .33 | .31 | .17 | .18 |
| T.E.E. Physics | .45 | .36 | .26 | .23 |
| T.E.E. Average | .47 | .38 | .25 | .23 |
| M.C. | .43 | .37 | .29 | .23 |
| A.H.S. | .41 | .33 | .27 | .20 |

All correlations significant at .01 level.

TABLE 3

GRADES IN THE MATRICULATION CERTIFICATE AS PREDICTORS OF AVERAGE YEARLY GRADES IN THE TECHNION

| Criteria / Predictor | A.Y.G. Freshmen | A.Y.G. Sophomore | A.Y.G. Junior | A.Y.G. Senior |
|---|---|---|---|---|
| Mathematics | .25 | .28 | .18 | .10* |
| Physics | .36 | .32 | .21 | .17 |
| Chemistry | .40 | .26 | .19 | .12* |
| Hebrew | .14 | .13 | .13 | .13 |
| Bible | .24 | .25 | .20 | .12* |
| History | x | x | x | .27* |
| English | .17 | .11* | .12 | x |

All correlations significant at .01 level. Those marked an * significant at .05 level; x refers to very low positive correlations, not significant, statistically which were omitted.

# PREDICTING ACADEMIC ACHIEVEMENTS FROM FRESHMEN THROUGH SENIOR COLLEGE YEARS*

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In a review of the literature, Lavin (1965) states that most studies of academic performance are concerned with the prediction of grades for the first semester, or at most, with the whole freshman year. There is a need, therefore, to explore the variability of academic performance of freshmen through their senior years of college. It is essential to identify consistent predictors--those which predict at one educational level but do not predict at a later time. Perlberg (1967) has reported the results of a longitudinal study on the predictive potential of the Israeli high school. Matriculation Certificate, and the Technion's Entrance Examination grades in predicting academic achievements in the Technion-Israel Institute of Technology from freshmen through senior years.

The following is a report of another study on prediction of academic achievement through college. An attempt was made to assess the potential of the Technion's average yearly grades (A.Y.G.) and grades in specific subjects in freshmen and sophomore years, in predicting academic achievements in junior and senior years. In addition, the possibility of improving prediction in college was examined by introducing additional variables to the analysis such as previous grades in the Matriculation Certificate, Entrance Examination and Average Yearly Grades.

The Technion is the only engineering school in Israel. It is known for its rigorous standards. It takes four years to obtain a B.S. degree, this in comparison to three years in other universities in Israel. During the first two years, the students of all departments study, for the most part, the same curriculum. This curriculum is composed of courses in the basic sciences and general engineering. The students are a highly select group and the persistence rate is high. To be promoted from year to year, the student has to achieve a required general average. Those who do not attain this average must repeat certain examination, the whole year, or leave the Technion.**

## Procedures

### Population

The classes starting their studies at the Technion in the years 1958-1960 were investigated. The total population studied in the three classes was 1,087 students. A four-year follow-up of each class was made.

### Predictors and criteria

Average yearly grades (a weighted average) and grades in specific subjects in freshmen and sophomore years were considered as predictors. High school Matriculation Certificate grades (M.C.) and the Technion's Entrance Examination grades (E.E.) were added as predictors in part of the analysis. The criterion variables were the average yearly grades (A.Y.G.) in the junior and senior years.

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*Professor S. Sacks, at present at Kansas State University, has advised on the statistical methods and analysis of results. Professor H. Hanani, Dr. M. Yadin and Mrs. Shimron contributed valuable remarks. Mrs. Y. Rom assisted in the pilot study. The author is indebted to them.

**For a more detailed description of the Technion and some aspects of the Israeli secondary school system see Perlberg, A. "Predicting Academic Achievements of Engineering and Science College Students," Journal of Educational Measurement, (in press 1967).

## The statistical method

Multiple correlations and multiple regression procedures were used in order to obtain optimal weights for the various subjects taught in the freshman year or for various other combined grades which were used as predictors.

## Results and Discussion

### Multiple correlations and regression weights for freshman year in predicting achievements in consecutive years

Table 1 presents the multiple correlation coefficients and regression weights for courses in the greshman year as predictors in the three consecutive years. The results for the total population are relatively high when compared with the average results in other prediction studies.

The regression weights would seem to be of special significance. Even though it would be improper to conclude from this study alone that the weights obtained are the "optimal weights" for other populations, it is still possible to suggest that previous assumptions in regard to the predictive value attributed to certain subjects taught at the Technion and other engineering schools in the freshman year are not always correct.

Grades in mathematics are generally regarded as good, if not the best predictors in engineering schools and therefore mathematics receives proportionately the largest weight in the curriculum and the computation procedures of the average yearly grade in the freshman year. However, the results obtained indicate that physics, chemistry and descriptive geometry have received larger weights in predicting achievements in sophomore and junior year. English had the largest weight in the senior year.

It is possible to suggest that since Technion students received a large dose of mathematics in high school and since mathematics is receiving greater emphasis in the Technion curriculum and the grading system, the population is relatively homogeneous in regard to this subject matter. Therefore, grades in other subjects are better predictors. This kind of reasoning is generally advocated by the mathematics department. On the other hand, people in other departments maintain that subjects such as physics combine essentials of mathematics with the ability to use them in the analysis of scientific phenomena. They are, therefore, better predictors for later years in colleges of engineering when students are confronted with problem-solving situations. Teachers of descriptive geometry suggest that their subject is a good predictor in engineering schools. A longitudinal ten-year study at Princeton University (Bigelow and Slaby) supports this assumption.

In the analysis according to departments there was a wide range in the multiple correlation coefficient obtained. This variability also appears to be true for the regression weights in the freshman year. Different weights were obtained for the various departments and it is suggested that in addition to the heterogeneous population there are also differences between the department in the application of various subject matter taught in the freshman year to the courses taught in the consecutive years. In some departments the relationship is strong and correlations are high as compared with others.

### Adding variables in the prediction process

The decision whether or not to promote a student in the Technion from one year to the next depends on the students achievements as reflected in his yearly average grade. Our previous prediction analysis followed this pattern. Table 2 presents the results of another analysis which attempts to examine whether the introduction of certain previous grades to the prediction analysis will yield a higher correlation. The results support this assumption. The general analysis of Table 1 applies also to this table.

Of special interest are the results indicating the relatively high weight that should be given to the Matriculation Certificate grades in predicting achievements. In the sophomore year it was relevant only in one department while in the senior year in five. It is again suggested that in the final year of college the population has become more homogeneous as a result of attrition. The factor of broad general education as indicated by high school grades, has an important role in predicting achievements.

Correlation between grades in basic courses and average yearly grades

Table 3 presents the correlation coefficients between grades in the basic courses in freshman and sophomore years and average yearly grades as well as correlation between grades in specific subjects in sophomore and freshman years.

All correlations obtained are relatively low and a combined predictor such as an average yearly grade yields higher correlation than any single grade. The results in Table 2 also support the previous discussion on the relative effectiveness of grades in specific subjects as predictors of academic achievements.

Grades in physics and chemistry had higher correlation with A.Y.G. 2-3-4 than mathematics. Descriptive geometry had higher correlation with A.Y.G. 3-4 than mathematics and English scored higher in fourth year. Similar results were also obtained between grades in the sophomore year and average yearly grades in the junior and senior year.

## Conclusion

Since there are relatively few studies on prediction within college years, the results obtained in this study need further validation. This is especially true in the case of the regression weights. However, certain trends do appear.

First, a population of a college of engineering which might be considered relatively homogeneous is heterogeneous enough to require special consideration in regard to selection procedures and prediction analysis in the various departments.

Second, the accepted notions about the predictive power of certain subjects taught in the freshman college year should be reexamined. In our specific case there is a need to examine whether the low predictive power of mathematics in comparison to physics and chemistry is caused by the homogeneity of the population, the poor relationship between subject matter taught in the freshman year and consecutive years or the nature of the subject matter as a predictor.

Third, in determining whether to promote a student from one year to the next, it is a better prediction of his chances for success to consider some of his previous achievements. This procedure is being followed by academic committees at the Technion in regard to some borderline students, but it would be worthwhile to apply it to the population as a whole.

## References


1. Lavin, D. E., The Prediction of Academic Performance, A Theoretical Analysis and Review of Research, New York, Russell Sage Foundation, 1965.
2. Perlberg, A., "Predicting Scholastic Achievements of Technion Students," Megamot. Child Welfare Research Quarterly, Volume XIV, No. 3, 1965, Jerusalem (In Hebrew).
3. Perlberg, A., "How to Predict Academic Achievements in the Technion" Megamot. Behavioral Science Quarterly, Volume XVIII, No. 1, 1967, Jerusalem, (In Hebrew).
4. Perlberg, A. "Predicting Academic Achievements of Engineering and Sciences College Students" Journal of Educational Measurements (in Press, 1967).
5. Biglow, A. L. and Slaby, S. M., The Predictive Value of Certain Freshmen Courses for Later Departmental Achievements in the School of Engineering at Princeton University. Department of Graphics, Princeton University, no date.

TABLE 1

Multiple Correlation and Regression Weights in % for Freshmen Courses (Mathematics, Physics, Chemistry, Descriptive Geometry and English) as Predictors of Average Yearly Grades (A.Y.G.) in Sophomore, Junior, and Senior Years

| | A.Y.G. Sophomore | | | | | | | A.Y.G. Junior | | | | | | | A.Y.G. Senior | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Regression Weights in % for freshmen courses | | | | | | | Regression Weights in % for freshmen courses | | | | | | | | Regression Weights in % for freshmen courses | | | | | |
| | N | R | Math | Phys | Chem | Desc Geom | Engl | N | R | Math | Phys | Chem | Desc Geom | Engl | N | R | Math | Phys | Chem | Desc Geom | Engl |
| Total Population | 696 | .61 | 17 | 43 | 24 | 16 | | 689 | .48 | 52 | 27 | 21 | | | 642 | .37 | 13 | 20 | 13 | 18 | 36 |
| DEPARTMENTS | | | | | | | | | | | | | | | | | | | | | |
| Ind. and Mang. Eng. | 37 | .55 | 100 | | | | | 43 | .59 | 39 | 20 | 27 | 14 | | 40 | x | | | | | |
| Civil Eng. | 136 | .57 | | 60 | | 40 | | 142 | .47 | 69 | | 31 | | | 127 | .39 | | | | 45 | 55 |
| Architecture | 29 | .63 | | | 100 | | | 27 | .71 | | 100 | | | | 24 | .76 | 33 | | 32 | 35 | |
| Mechanical Eng. | 223 | .60 | 24 | 52 | | 24 | | 220 | .53 | 47 | | 53 | | | 210 | .50 | | | 44 | 56 | |
| Electrical Eng. | 173 | .69 | 25 | 36 | 23 | | 16 | 172 | .58 | 50 | 21 | 15 | 14 | | 163 | .44 | | | 45 | 55 | |
| Mathematics and Physics | 48 | .73 | 34 | 66 | | | | 45 | .59 | 100 | | | | | 44 | .57 | | 100 | | | |
| Chemistry | 35 | .59 | | 100 | | | | 32 | .64 | 27 | 35 | 21 | 17 | | 31 | x | | | | | |
| Chemical Eng. | 85 | .72 | 26 | 45 | 29 | | | 86 | .66 | 44 | | 56 | | | 80 | .49 | 54 | | 46 | | |
| Agricultural Eng. | 44 | .62 | | 100 | | | | 41 | .74 | 45 | | 55 | | | 38 | x | | | | | |
| Aeronautical Eng. | 43 | .80 | 39 | 28 | 33 | | | 40 | .70 | | 62 | 38 | | | 37 | .69 | | 52 | | | 48 |

All correlations are significant at .01 level. x refers to very low positive correlation, not significant statistically and were omitted.

TABLE 2

Multiple Correlations and Regression Weights (R.W.) in %. Average Matriculation Certificate Grades (M.C.); Technion Entrance Examination (E.E.) and Average Yearly Grades (A.Y.G.) as Predictors of A.Y.G.

| | R.W. for A.Y.G. Sophomore | | | | | R.W. for A.Y.G. Junior | | | | | | R.W. for A.Y.G. Senior | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | R | MC | EE | AYG I | N | R | MC | EE | AYG I | AYG II | N | R | MC | EE | AYG I | AYG II | AYG III |
| Total Population | 650 | .64 | | 15 | 85 | 617 | .70 | | 10 | 19 | 71 | 583 | .62 | | | | 34 | 66 |
| DEPARTMENTS | | | | | | | | | | | | | | | | | | |
| Ind. and Mang. Eng. | 32 | .55 | | | 100 | 31 | .68 | 64 | | | 36 | 30 | .80 | 30 | 24 | 25 | 21 | |
| Civil Eng. | 107 | .66 | | | 100 | 103 | .74 | | | | 100 | 98 | .66 | | | | | 100 |
| Architecture | 42 | .58 | | | 100 | 34 | .76 | | | 59 | 41 | 36 | .71 | | | 100 | | |
| Mechanical Eng. | 150 | .64 | | | 100 | 141 | .71 | | | | 100 | 133 | .49 | | | | 52 | 48 |
| Electrical Eng. | 115 | .66 | | 39 | 61 | 111 | .64 | | | 25 | 75 | 107 | .62 | 31 | 18 | | 27 | 24 |
| Mathematics and Physics | 47 | .82 | 35 | 27 | 38 | 44 | .66 | | | | 100 | 43 | .73 | | | | | 100 |
| Chemistry | 23 | .79 | | 46 | 54 | 22 | .75 | | 48 | 52 | | 21 | x | | | | 100 | |
| Chemical Eng. | 73 | .76 | | 30 | 70 | 71 | .80 | | | | 100 | 66 | .78 | 42 | | | | 58 |
| Agricultural Eng. | 28 | .56 | | | 100 | 25 | .88 | | | | 100 | 23 | .80 | 56 | 44 | | | |
| Aeronautical Eng. | 38 | .85 | | | 100 | 35 | .74 | 100 | | | | 31 | .84 | 77 | | | | 23 |

TABLE 3

Correlations Between Grades in Basic Courses and Average Yearly Grades (A.Y.G.)

| Predictor | Criterion | N | r | Predictor | Criterion | N | r |
|---|---|---|---|---|---|---|---|
| Math - 1 | Math - 2 | 700 | .37 | Chem.- 1 | A.Y.G.- 2 | 594 | .41 |
| Math - 1 | Phys.- 2 | 701 | .36 | Chem.- 1 | A.Y.G.- 3 | 602 | .37 |
| Math - 1 | Mech.- 2 | 680 | .39 | Chem.- 1 | A.Y.G.- 4 | 548 | .17 |
| Math - 1 | A.Y.G.-2 | 624 | .39 | Desc.-Geom. | A.Y.G.- 2 | 582 | .30 |
| Math - 1 | A.Y.G.-3 | 629 | .27 | Desc.-Geom. | A.Y.G.- 3 | 587 | .30 |
| Math - 1 | A.Y.G.-4 | 571 | .16 | Desc.-Geom. | A.Y.G.- 4 | 537 | .21 |
| Phys.- 1 | Math - 2 | 703 | .32 | English 1 | A.Y.G.- 2 | 620 | .18 |
| Phys.- 1 | Phys.- 2 | 704 | .38 | English 1 | A.Y.G.- 3 | 625 | .16 |
| Phys.- 1 | Mech.- 2 | 683 | .43 | English 1 | A.Y.G.- 4 | 568 | .23 |
| Phys.- 1 | A.Y.G.-2 | 626 | .47 | Math - II | A.Y.G.- 3 | 630 | .25 |
| Phys.- 1 | A.Y.G.-3 | 632 | .38 | Math - II | A.Y.G.- 4 | 573 | .33 |
| Phys.- 1 | A.Y.G.-4 | 574 | .19 | Phys.- II | A.Y.G.- 3 | 631 | .33 |
| Chem.- 1 | Math - 2 | 672 | .22 | Phys.- II | A.Y.G.- 4 | 514 | .39 |
| Chem.- 1 | Phys.- 2 | 672 | .34 | Mech.- II | A.Y.G.- 3 | 615 | .47 |
| | | | | Mech.- II | A.Y.G.- 4 | 558 | .28 |

All correlations are significant at .01 level.